



Plio-Pliocene vole fauna from Zverinogolovskoye locality (Southern Trans-Urals region)

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ARTICLE INFO

Article history:

Available online 4 June 2012

ABSTRACT

The Plio-Pleistocene arvicoline fauna of Zverinogolovskoye is revised. The molar morphology of *Pliomys* sp., *Borsodia praeungarica*, *Pitymimomys ex gr. inceptor*, *Pitymimomys baschkiricus*, *Mimomys ex gr. haj-nackensis*, *Mimomys polonicus*, *Mimomys hintoni*, and *M. cf. reidi* is described. Biozones of most forms indicate the Late Pliocene–earliest Pleistocene interval (Villanyian European Land Mammal Age, zones MN16 to MN17). The vole fauna includes common species occurring in Western Europe, the Russian Plain, and West Siberia.

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1. Introduction

The Trans-Ural region is situated between the Ural Mountains and the West-Siberian Plain. The contact and mutual enrichment of the East European and West Siberian faunal assemblages is characteristic for this area. This is why this region is important for reconstruction of the faunal history of the Palearctic and for direct correlations of European and Siberian stratigraphic schemes.

Several publications have considered the Pleistocene and Holocene rodent history in the Trans-Urals (e.g., Maleeva, 1982; Maleeva and Stefanovskii, 1988; Ivakina et al., 1997; Stefanovskii and Borodin, 2002; Stefanovskii et al., 2003; Kuzmina, 2009).

The only source of information on the late Pliocene – earliest Pleistocene history of small mammals in the region is the materials from the Zverinogolovskoye locality. The locality is situated in the Tobol River basin near Zverinogolovskoye settlement (Kurgan administrative region of Russia, southern Trans-Urals geographic region) (54°27'N, 64°53'E). The studied sections are located in the brick factory clay and sand pit at the south-eastern margin of the settlement and in natural exposures in the right bank of the Zverinka River.

The geological structure of the locality was described by Stefanovskii and Pogodina (2005). The main exposure at the brick factory has the following structure, from the surface downwards (Fig. 1; Table 1):

The fossiliferous deposits (bed 4) that yield small vertebrate fauna reviewed in this article belong to the Late Pliocene to Early Pleistocene Zverinogolovskoye Formation (beds 3–7), underlain by clays of the Late Oligocene Chegan Formation (bed 8), and crowned by Late Pleistocene loess-like deposits (bed 2). The paleomagnetic study of the thin layered silty member (bed 4, depth 2.4–6.5 m) was carried out by D.K. Nurgaliev (Kazan State University) and revealed positive magnetization interpreted as an interval of the upper part of the Gauss Chron (C2An.1n, ca. 2.58–3.0 Ma).

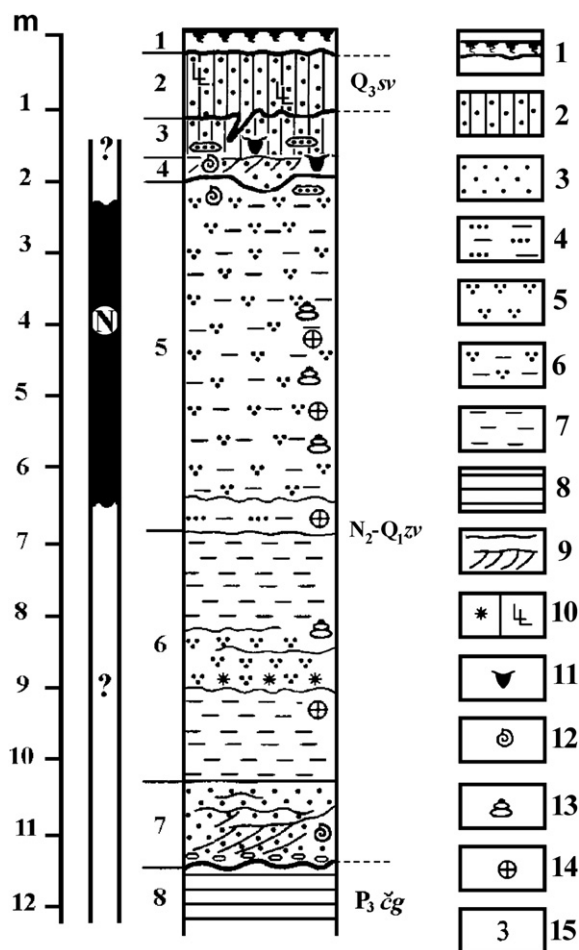
The palynological analysis of the Zverinogolovskoye Fm revealed three phases of vegetation development. The lower member (bed 7) shows a forest-steppe spectrum that corresponds to landscapes of mixed birch-pine forests with spruce, aspen, alder and broadleaved trees (*Tilia*, *Ulmus*, *Corylus*). The middle member (beds 6–5) yielded a steppe assemblage, which is dominated by pollen of *Artemisia* (40–66% of the general pollen composition), *Chenopodiaceae* (up to 20%), *Compositae* (up to 14%) and meadow herbs (up to 6%). Arboreal species abruptly decrease (to 12%) and the cold-loving shrub *Alnaster* sp. appears in this group. The upper part of the section (beds 3–4) is characterized by a forest pollen association with considerable components of coniferous (*Abies* sp., *Pinus sibirica*, *Picea* sp.) and broadleaved forms including *Tilia* (up to 8%) (Stefanovskii and Pogodina, 2005).

The Zverinogolovskoye snail fauna is similar to Late Pliocene and Early Pleistocene (Gelasian) associations from West Siberia. It combines some Pliocene species (*Borysthenia pronaticina* (Lindh.), *Bithynia kirgizorum* (Lindh.), *Valvata klinensis* Mil.) and a wide range of Quaternary forms (Stefanovskii and Pogodina, 2005).

Judging from the taxonomic composition of the ostracod association, it is stratigraphically intermediate between the Beteke and

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**Table 1**

Stratigraphy of Zverinogolovskoye locality.

Beds	Lithology	Thickness, m
1.	Modern soil.	0.1
2.	Silty loam, brown, with columnar texture, calcareous. The lower boundary is erosional.	1.0
3.	Silty loam light brown, with lenticular interbeds of fine-grained locally clayey dark gray sand.	0.7
4.	The lower part of the bed yielded a mammalian rib. Interlayering of lenticular interbeds of light gray fine-grained sand with clayey intercalations and middle to large grained brown sand with signs of carbonatization. The bed produced shells of mollusks, bones of mammals, and redeposited shark teeth.	0.3
5.	Silty loam, clayey, brown, with lenses of middle-grained sand.	4.6
6.	Clays, bluish gray, hydromicaceous kaolinite, locally thin layered with inclusions of white micaceous silts, or red brown iron crusts on bedding planes, locally lumpy with uneven fracture.	3.5
7.	Sands, yellowish gray, predominantly quartz with occasional gravel of quartz and flint, degree of rolling 3–4, with wavy bedding and in lenses cross bedding, rare shells of fresh-water snails, with spots and areas of secondary ferrugination. The lower contact is distinct, erosional	1.3
8.	Clays, dark blue, thin layered with inclusions of marcasite	0.6

figure captions, specimens are referred to as follows: the specimen numbered ZMUU1001 is labeled Zv1001.

Upper molars are denoted as M1, M2, M3, and lower molars as m1, m2, m3. Measurements follow the system of Tesakov (2004). The elements of the crowns were measured using an ocular scale with the binocular microscope. All measurements are in millimeters.

Terminology of the occlusal surfaces follows van der Meulen (1973), names of dentine tracts are after Rabeder (1981). Drawings of the material were made using a lucida camera-equipped binocular microscope.

Processing of digital data was conducted using MS Excel and Statistica version 6.0 (Statsoft, 2001). The main purpose of computer processing was the computation of statistical parameters for variation of the experimental data (mean (MEAN), standard error of mean (SE), standard deviation (SD), and coefficient of variation (CV). The study used the current international stratigraphic scheme of the International Commission on Stratigraphy (2010) with Neogene-Quaternary boundary at the Piacenzian/Gelasian transition, and the current stratigraphic scheme of the Russian Interdepartmental Stratigraphic Committee.

3. Description of the material

3.1. Dentine tracts of individual samples

Variability in height of dentine tracts was studied. All types of molars were examined but the analysis of dentine tract height in the posterior loop of the m1 was of the greatest interest (Fig. 2). Only molars with low tracts were present in the collection of 1991. Molars with medium-height dentine tracts dominated the collection of 2009. Molars with medium and high dentine tracts were present in the collection of 1994–95. The collection of 1970–72 was the most heterogeneous: molars with low, medium, and high dentine tracts were present in that collection. This shows that the Zverinogolovskoye material probably contains molars of different evolutionary levels. The samples of 1994–95 and 2009 are relatively homogeneous and contain a mostly Late Villanyian (MN17) association with a small admixture of MN16 species.

Fig. 1. Section Zverinogolovskoye (exposure 109 in Stefanovskii and Pogodina, 2005). 1. modern soil; 2. silty loam; 3. variably-grained sand; 4. fine-grained clayey sand; 5. silt; 6. silty loam, clayey; 7. lumpy clay; 8. laminated clay; 9. cross-bedding; 10. ferrugination and calcareous concretions; 11. mammalian remains; 12. shells of mollusks; 13. ostracods; 14. palynology; 15. bed numbers. N – normal magnetization. Regional stratigraphic units (Stefanovskii and Pogodina, 2005): Q_{3sv} – Severouralsk super-horizon, Upper Pleistocene; N₂–Q_{1zv} – Zverinogolovskaya Fm, Upper Pliocene–Early Pleistocene; P_{3cg} – Chegan Fm, Upper Oligocene.

Kochkovka assemblages in southwest Siberia. The ostracod fauna contains both ancient species (*Ilyocypris manasensis* Mand., *Dolerocypris fasciata* (Müll.), *Cypria candonaeformis* (Schw.)), and more advanced forms (*Ilyocypris bella* Sharap., *I. caspiensis* Neg., *Candoniella schubinae* Mand., *Cyclocypris laevis* Müll.) that are common in the Middle-Late Pleistocene (Stefanovskii and Pogodina, 2005).

The field campaigns in 1970–72 organized by A.G. Maleeva, and in 1991, 1994, 1995 headed by the present authors have produced several collections of small vertebrates. The species composition of these remains was reported earlier (Stefanovskii and Pogodina, 2005). New remains of micromammals from sand bed 4 (Fig. 1) were found during the field campaign in 2009. The total general composition of the small mammal fauna is shown in Table 2.

The main aim of this study is to provide an overview of the small mammal fauna from Zverinogolovskoye, with special focus on rhizodont arvicoline rodents and their molar morphology, and the biochronological position of the fauna.

2. Material, methods and terminology

The collection described here is preserved in the Zoological Museum of the Ural University, Ekaterinburg, Russia (ZMUU). In the

Table 2
Composition of small mammal fauna.

Taxonomic composition	Age			
	Upper Pliocene	Earliest Pleistocene	Early Pleistocene	Middle-Late Pleistocene
Lagomorpha				
<i>Pliolagus</i> sp. ^a		+		
<i>Pliolagomys kujalnikensis</i> Topacevski et Scorik, 1977 ^a		+		
<i>Ochotonoides complicidens</i> Boulte et Teilhard, 1928 ^a		+		
Rodentia				
<i>Spermophilus</i> sp.				+?
<i>Marmota</i> sp.				+?
<i>Sminthinae</i>		+		
<i>Plioscirotopoda</i> sp.			+	
<i>Prosiphnaeus</i> sp.		+		
<i>Pliomys</i> sp.	+			
<i>Lagurus lagurus</i> Pallas, 1773				+
<i>Eolagurus luteus</i> Eversmann, 1840				+
<i>Borsodia praeungarica</i> Schevtschenko, 1965		+		
<i>Pitymimomys</i> ex gr. <i>inceptor</i> Tesakov, 2003	+			
<i>Pitymimomys baschkiricus</i> Suchov, 1970		+		
<i>Mimomys</i> ex gr. <i>hajnachensis</i> Fejfar, 1961	+			
<i>Mimomys polonicus</i> Kowalski, 1960		+		
<i>M. hintoni</i> Feifar, 1961		+		
<i>M. ex gr. hintoni</i> Feifar, 1961	+			
<i>Mimomys</i> cf. <i>reidi</i> Hinton, 1910		+		
<i>Mimomys</i> sp.	+	+		
<i>Allophaiomys deucalion</i> Kormos, 1932			+	
<i>Microtus gregalis</i> Pallas, 1779				+
<i>Microtus</i> sp.				+?

^a Identified by Dr. M. Erbaeva (Ulan-Ude).

3.2. Species morphology

Family CRICETIDAE Fischer, 1817
Subfamily ARVICOLINAE Gray, 1821
Genus *Pliomys* Méhely, 1914.
***Pliomys* sp.**

Fig. 3: 1.

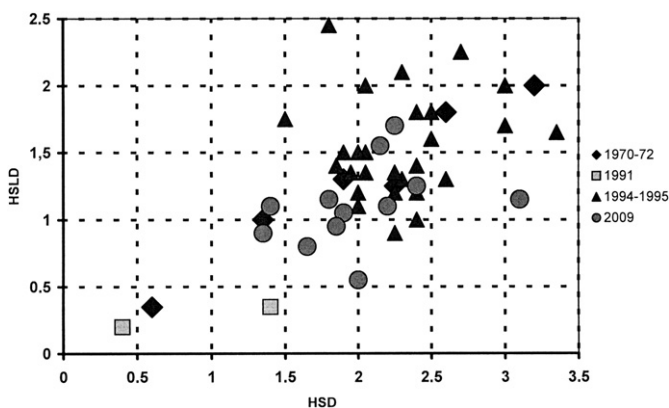


Fig. 2. Heights of dentine tracts of the posterior loop in m1 (all species). HSD, hypoinsulid = labial posterior dentine tract; HSLD, hypoinsulid = lingual posterior dentine tract.

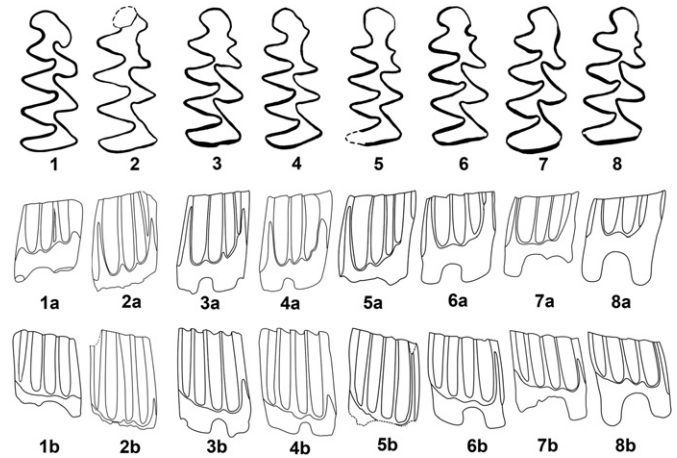


Fig. 3. Molar morphology of *Pliomys* sp. (1), *Borsodia praeungarica* (2–8). 1–8 – occlusal surface, m1; a – labial view; b – lingual view. 1. Zv1728, 2. Zv1012, 3. Zv1781, 4. Zv1013, 5. Zv1753, 6. Zv1755, 7. Zv1760, 8. Zv1773.

Description

m1 has the following dimensions: $L = 2.35$; $W = 0.9$; $Asd = 0.8$; $Hsd = 0.4$; $Hsl = 0.2$; $Lbas = 2.5$; $H = 2$. The molar has no cement, no enamel islet, no *Mimomys* ridge. The flat tip of BRA3 may indicate, however, a strongly reduced condition of this ridge. The enamel is not differentiated. Dentine tracts are very low.

The length of anteroconid is near to half of the tooth full length ($A/L = 48.94$). The anteroconid cap (ACC) has a mushroom-like shape.

Comparison

In general occlusal outline and dimensions, this molar is similar to *Pliomys destinatus* Tesakov (2005) (MN15). It is distinct in having lower dentine tracts. Morphologically similar molars were described by Zazhigin among a sample of *Promimomys gracilis* from Beteke locality (Zazhigin, 1980).

Comments. *Pliomys* probably represents a reworked early Vilnyan material.

Genus *Borsodia* Janossy and van der Meulen, 1975

Medium-sized forms without cement. The m1 has no enamel islet. The posterior lobe of the M3 is simplified with the formation of an enamel islet. The enamel band shows no differentiation or has the positive type of differentiation.

Borsodia praeungarica Schevtschenko, 1965

Fig. 3: 2–8; 4: 1–2; Tables 3 and 4

Description

m1. Medium-sized forms (Table 3). Enamel band shows no differentiation. The *Mimomys* ridge is well developed on the most of molars. Three molars show slight traces of a *Mimomys* ridge visible on the buccal side, although they are not clearly seen on the occlusal surface (Fig. 3: 2, 4, 7).

M3. Medium-sized forms (Table 4). Molars have the enamel islet in the posterior lobe, disappearing with wear.

Table 3
Dimensions of *Borsodia praeungarica*, m1.

	N	Mean	SE	Min	Max	SD	CV
L	16	2.58	0.029	2.45	2.85	0.117	4.55
W	20	1.11	0.015	1.00	1.25	0.067	6.04
ASD	7	1.91	0.075	1.65	2.25	0.199	10.42
HSD	9	2.21	0.157	1.40	2.90	0.470	21.27
HSLD	10	1.38	0.114	0.80	2.00	0.360	26.09
L.BAS	13	2.69	0.030	2.45	2.90	0.106	3.94
EI	18	1.08	0.058	0.70	1.50	0.245	22.69
A/L	18	45.03	0.421	42.00	49.02	1.787	3.97

Table 4
Dimensions of *Borsodia praeungarica*, M3.

	N	Mean	SE	Min	Max	SD	CV
L	8	1.69	0.075	1.35	1.95	0.212	12.54
W	8	0.89	0.029	0.75	1.00	0.082	9.21
DS	7	0.95	0.048	0.75	1.10	0.126	13.26
AS	6	1.43	0.153	1.10	2.10	0.374	26.15
PRS	5	0.79	0.068	0.60	1.00	0.152	19.24

Comparison

Size and height of tracts are similar to those in the molars of *Borsodia praeungarica* from Veselovka, Kryzhanovka 2, Liven-tzovka G localities dating from the transition from early to late Villanyian (Tesakov, 2004) or to Late Pliocene or earliest Pleistocene.

Genus *Pitymimomys* Tesakov, 1998

Medium-sized forms with cement. Cement accumulations are sparse, non-uniform. First lower molars with enamel islet. M3 has anterior and posterior enamel islets. The enamel band shows no differentiation or has the negative type of differentiation.

Pitymimomys ex gr. inceptor Tesakov, 2003

Fig. 5: 1.

Description

m1. This group includes a very small brachyodont molar of “*Pitymimomys*” appearance. It has the following dimensions: $L = 2.15$; $W = 1.05$; $Hsd = 0.6$; $Hsld = 0.35$; $Lbas = 2.3$; $H = 2$; $A/L = 41.86$. Cement accumulations are sparse. The enamel is not differentiated. Dentine tracts are very low. Enamel islet and Mimomys ridge are present.

Comparison

The molar is similar in description to *P. inceptor* (Tesakov, 2004) from Ripa Skortselskaya, but has slightly smaller size and lower dentine tracts.

Pitymimomys ex gr. baschkiricus (Suchov, 1970)

Fig. 5: 2.

Description

The molar has the following dimensions: $L = 2.6$; $W = 1.05$; $Hsd = 2$; $Hsld = 1.15$; $Lbas = 2.8$; $H = 3.45$; $A/L = 44.23$. The morphology is similar to *Promimomys baschkiricus*. It differs from *Promimomys baschkiricus* in lower hypsodonty. Cement accumulations are very sparse. The molar is very young (merhorhizal phase). The enamel islet is not yet formed. The islet fold reduces when the crown height is about 3.4 mm.

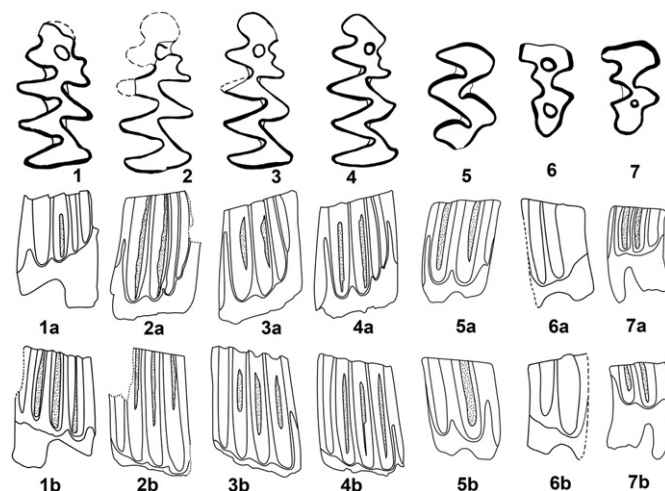


Fig. 5. Molar morphology of *Pitymimomys ex gr. inceptor* (1), *P. ex gr. baschkiricus* (2), *P. baschkiricus* (3–7). 1–4: m1, 5: M2; 6–7: M3; 1–7: occlusal surface; a – labial view; b – lingual view. 1. Zv1129, 2. Zv1019, 3. Zv1763, 4. Zv1765, 5. Zv1124, 6. Zv1316, 7. Zv1054.

Comparison

The molar is similar to the description of *P. baschkiricus* from Simbugino (Tesakov, 2004).

Comments. The primitive *Pitymimomys* species likely represent material reworked from lower Villanyian sediments.

Pitymimomys baschkiricus (Suchov, 1970)

Fig. 5: 3–7, Table 5

Description

m1. Medium-sized molars (Table 5) with relatively narrow occlusal surface. The dentine tracts are high. The enamel islet is small and round. The islet fold reduces when the crown is high. All molars in our collection have reduced islet fold.

M2. $L = 2.1$; $W = 1.4$. Triangular fields T2–T3 (paracone and hypocone) widely confluent (Fig. 5: 5).

M3. Molars have the following dimensions: $L = 1.6$; $W = 1$; $Ds = 1.1$; $Prs = 0.6$; $H = 1.3$; $L = 1.5$; $W = 0.8$; $Ds = 1.8$; $H = 2.1$ and $L = 1.5$; $W = 0.9$; $Ds = 0.25$; $H = 2.15$. Two molars have two enamel islets (Fig. 5: 6). The anterior islet disappears early with wear, and the anterior lobe becomes widely confluent with the second triangle (Fig. 5: 7).

Comparison

Size and height of tracts are similar to those on the molars from Akkulaevo locality dating back to the late Pliocene (Tesakov, 2004). However, the form from Zverinogolovskoye has slightly higher dentine tracts, possibly indicating a younger geological age.

Genus *Mimomys* F. Major, 1902

Medium sized and large voles. Molars with cement. The m1 has an enamel islet. M3 has a posterior enamel islet. Dentine tracts are moderately elongated.

Table 5
Dimensions of *Pitymimomys baschkiricus*, m1.

	N	Mean	SE	Min	Max	SD	CV
L	11	2.54	0.018	2.45	2.65	0.058	2.28
W	13	1.14	0.022	1.05	1.30	0.079	6.93
ASD	2			2.95	3.25		
HSD	5	2.86	0.087	2.60	3.00	0.195	6.82
HSLD	8	1.88	0.108	1.30	2.25	0.305	16.22
L_BAS	9	2.73	0.026	2.55	2.80	0.079	2.89
EI	12	1.26	0.094	0.70	1.75	0.327	25.95
A/L	11	42.04	0.418	40.00	44.23	1.385	3.29

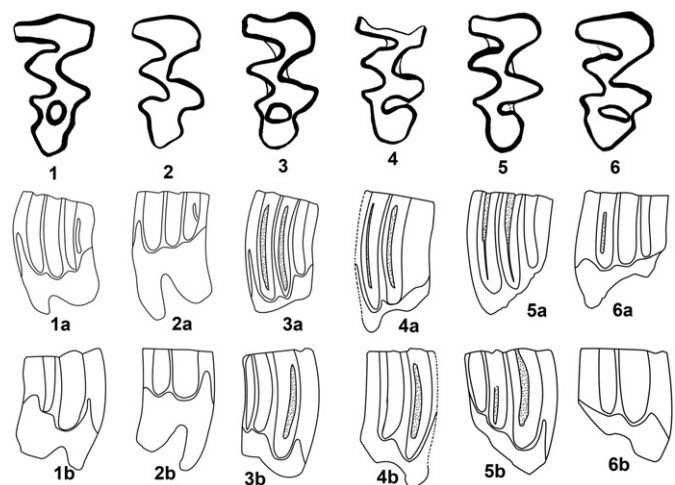


Fig. 4. Morphology of M3: *Borsodia praeungarica* (1–2), *Mimomys hintoni* (3–5), *M. ex gr. hintoni* (6). 1–6: occlusal surface; a – labial view; b – lingual view. 1. Zv1307, 2. Zv1313, 3. Zv1315, 4. Zv1319, 5. Zv1314, 6. Zv1045.

Table 6
Dimensions of *Mimomys hintoni*, m1.

	N	Mean	SE	Min	Max	SD	CV
L	22	2.75	0.027	2.50	3.00	0.126	4.58
W	27	1.31	0.017	1.05	1.40	0.088	6.72
ASD	3			2.25	2.90		
HSD	12	2.20	0.096	1.35	2.50	0.331	15.05
HSLD	19	1.32	0.054	0.90	1.80	0.331	25.08
L_BAS	18	2.81	0.025	2.60	3.00	0.105	3.74
El	27	1.07	0.058	0.30	1.55	0.303	28.32
A/L	22	42.19	0.700	36.36	48.15	3.287	7.79

Mimomys ex gr. hajackensis Fejfar, 1961

Fig. 7: 1.

Description

m1. The only molar is large. It has the following dimensions: $L = 3.4$; $W = 1.5$; $Hsld = 0.35$; $Lbas = 3.4$; $H = 1.4$; $A/L = 42.65$. Enamel islet and *Mimomys* ridge are well developed. The molar of *Mimomys ex gr. hajackensis* has a very low lingual tract ($Hsld = 0.35$).

Comparison

The height of hyposinulid is similar to *Mimomys ex gr. hajackensis* from Ripa Skortselskaya (Tesakov, 2004).

Comments. Sporadic remains of this form probably represent reworking from early Villanyian deposits.

Mimomys polonicus Kowalski, 1960

Fig. 7: 2–3.

Description

m1. Very large vole. The only molar has the following dimensions: $L = 3.3$; $W = 1.6$; $Hsld = 1.1$; $Lbas = 3.45$; $H = 2$; $A/L = 46.97$. The enamel islet and *Mimomys* ridge are well developed.

M3. Molars have the following dimensions: $L = 2.2$; $W = 1.4$; $Ds = 1.35$; $Prs = 1.15$; $H = 2.8$ and $L = 2.15$; $W = 1.45$; $Ds = 1$; $As = 1.25$; $Prs = 1.2$; $H = 2.2$. Molars have the enamel islet in the posterior lobe (Fig. 7: 3).

Comparison

The height of hyposinulid of *M. polonicus* is similar to that from Kushkuna (Tesakov, 2004).

Mimomys hintoni Fejfar, 1961

Fig. 4: 3–5; 6; Tables 6 and 7

Description

m1. Many molars were identified as belonging to the species *M. hintoni*. These are medium-sized molars with relatively wide occlusal surface; dentine tracts are rather low (Table 6). Cement accumulations are moderate. The enamel islet is not yet formed in young molars being present as an islet fold (Fig. 6: 1). The islet fold reduces when the crown height is about 2.8 mm (rhizodont stage), the islet is slightly oval (Fig. 6: 2, 3) and long persistent.

M3. Medium-sized molars (Table 7). M3 has a deep first buccal reentrant angle, which never forms an anterior enamel islet, and a deep third lingual reentrant angle, which forms the posterior enamel islet when the crown height is about 2.6–2.7 mm.

Comparison

In general the heights of dentine tracts of *Mimomys hintoni* molars from Zverinogolovskoye fall in the range between the values

Table 7
Dimensions of *Mimomys hintoni*, M3.

	N	Mean	SE	Min	Max	SD	CV
L	6	1.73	0.063	1.45	1.85	0.154	8.90
W	11	0.96	0.035	0.70	1.10	0.116	12.08
DS	10	0.99	0.087	0.45	1.35	0.271	27.33
AS	8	1.26	0.091	0.90	1.60	0.257	20.40
PRS	7	0.83	0.084	0.60	1.15	0.221	26.63

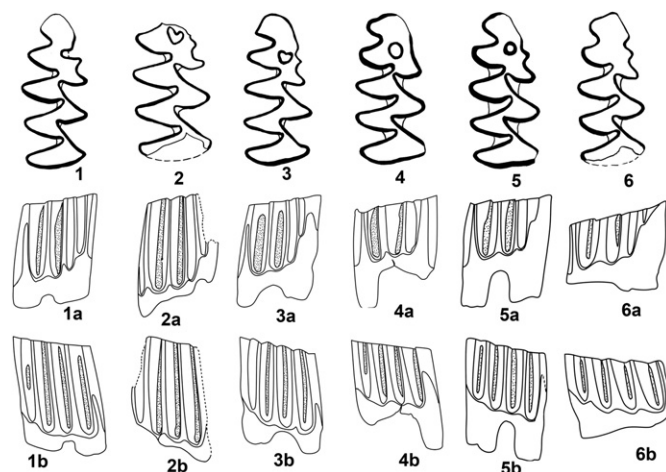


Fig. 6. Molar morphology of *Mimomys hintoni*, m1. 1–6: occlusal surface; a – labial view; b – lingual view. 1. Zv1767, 2. Zv1009, 3. Zv1766, 4. Zv1122, 5. Zv1738, 6. Zv1775.

of *M. hintoni hintoni* from Simbugino and Akkulaevo, and *M. hintoni livenzovicus* (Veselovka, Kryzhanovka 2, Liventzovka G) dating from the transition from early to late Villanyian (Tesakov, 2004) and to Late Pliocene–earliest Pleistocene interval.

Mimomys ex gr. hintoni Fejfar, 1961

Fig. 4: 6.

Description

The collection includes one M3 with very low dentine tracts and very sparse cement accumulations (Fig. 4: 6). This molar has the following dimensions: $L = 1.9$; $W = 1.2$; $Ds = 0.25$; $As = 0.25$; $Prs = 0.55$; $H = 1.7$.

Comparison

In occlusal pattern this M3 matches *M. hintoni* (for example see Fig. 4: 4) but differs in lower dentine tracts.

Comments. Remains of this form probably represent reworking from early Villanyian deposits.

Mimomys cf. reidi Hinton, 1910

Fig. 7: 4–7, Table 8

Description

m1. Medium-sized molars (Table 8). Cement accumulations are abundant. Molars have the *Mimomys* ridge. Anteroconid is narrow. Young animals have an enamel islet, it is round and disappears

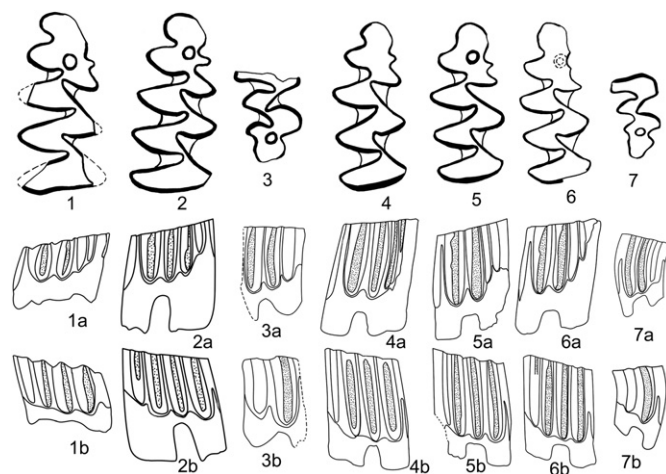


Fig. 7. Molar morphology of *Mimomys ex gr. hajackensis* (1), *M. polonicus* (2–3), *M. cf. reidi* (4–7). 1–2, 4–6: m1, 3, 7: M3; 1–7: occlusal surface; a – labial view; b – lingual view. 1. Zv1727, 2. Zv1737, 3. Zv1324, 4. Zv1148, 5. Zv1006, 6. Zv1005, 7. Zv1020.

Table 8
Dimensions of *Mimomys cf. reidi*, m1.

	N	Mean	SE	Min	Max	SD	CV
L	7	2.65	0.041	2.50	2.80	0.108	4.08
W	7	1.16	0.023	1.05	1.25	0.061	5.26
HSD	4	2.05	0.098	1.80	2.25	0.196	9.56
HSLD	4	1.55	0.143	1.15	1.80	0.286	18.45
L_BAS	5	2.78	0.041	2.70	2.90	0.091	3.27
El	6	1.03	0.131	0.50	1.50	0.320	31.07
A/L	7	41.57	1.151	38.46	47.05	3.044	7.32

quickly with wear. One molar has a trace of enamel islet (crown height is 2.7 mm, Fig. 7: 6).

M3. The molars have the following dimensions: $L = 1.9$; $W = 1.1$; $Ds = 1.25$; $As = 1.2$; $Prs = 1.35$; $H = 2.9$ and $L = 1.9$; $W = 1.1$; $Ds = 1.25$; $As = 1.35$; $Prs = 1.05$; $H = 2.35$. The molars have an enamel islet in the posterior lobe. Cement accumulations are abundant.

Comparison

These molars combine the following features. On the one hand, cement accumulations are abundant and enamel islet disappears quickly with wear (as in *M. pusillus* or *M. reidi*). On the other hand, the heights of dentine tracts are medium (as in *Mimomys hintoni*). We could not find an exact match of this form in the literature.

4. Conclusions

1. Most of the described forms (*B. praehungarica*, *P. baschkiricus*, *M. polonicus*, *M. hintoni*, *M. ex gr. reidi*) existed during the time range from the late Late Pliocene to the beginning of the Early Pleistocene (MN16b–MN17). The material also contains some species (*Pliomys* sp., *P. ex gr. inceptor*, *M. ex gr. hajackensis*) with much lower hypsodonty, which indicate early Late Pliocene (MN16a) age.
2. The arvicoline fauna comprises the usual species occurring in the Western Europe, Russian Plain and West Siberia. Some specific zoogeographical features of the Zverinogolovskoye fauna can be noted. The fauna does not contain typical central and eastern European voles of the genus *Dolomys* (Agadjanjan, 2009). Remains of *Pliomys*, *M. hajackensis*, and *M. polonicus* are quite rare. The presence of the mole rat (*zokor*) *Prosiphneus* shows connections with faunas from southern cis-Urals, West Siberia, and Transbaikalia. There were no remains of Muridae found. This is also characteristic for synchronous faunas of West Siberia. Based on these features, the fauna of Zverinogolovskoye appears to be similar to synchronous faunas

known in southern cis-Urals (Tesakov, 2004) and Western Siberia (Zazhigin, 1980).

Acknowledgements

The study was partially supported by the RAS Program “The Problems of the Origin of Life and Biosphere Development” (N°12-P-4-1050), and the grant for support of the Leading Scientific Schools of Russia (NSH-5325.2012.4).

We are greatly indebted to N.L. Pogodin and T.A. Rupysheva for their practical help in the collecting of the material. We are also most grateful to A.V. Borodin and A.S. Tesakov for helpful suggestions and discussions. We thank M.K. Khorosh for making the illustrations.

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